

APPENDIX: Supplementary tables [posted as supplied by author]

Table A: Guide to scoring QUADAS Quality Assessment items.

Item	Criteria and score	
1	Was the spectrum of patients representative of the patients who will receive the test in practice? Is it a selective sample of patients?	
	Yes	A consecutive series of patients or a random sample has been selected. Information should be given about setting, inclusion and exclusion criteria, and preferably number of patients eligible and excluded. If a mixed population of primary and secondary care patients is used: the number of participants from each setting is presented
	No	Healthy controls are used. Also, score 'no' if non-response is high and selective, or there is clear evidence of selective sampling. Also, score 'no' if a population is selected that is otherwise unsuitable, for example, >10% patients are known to have other specific causes of LBP (severe OA, fracture, etc)
	Unclear	Insufficient information is given on the setting, selection criteria, or selection procedure to make a judgment
2	Is the reference standard likely to classify the target condition correctly?	
	Yes	One of: 1) plain radiography; 2) magnetic resonance imaging (MRI); 3) computed tomography (CT); or 4) other imaging tests such as bone scan; is used as a reference standard
	No	Seriously questioning the methods used, if consensus among observers, or an unknown combination of the clinical assessment ("clinical judgment") is used as reference standard
	Unclear	Insufficient information is given on the reference standard to make an adequate assessment
3	Is the time period between the reference standard and the index test short enough to be reasonably sure that the target condition did not change between the two tests?	
	Yes	The time period between clinical assessment and the reference standard is one week or less
	No	The time period between clinical assessment and the reference standard is longer than one week
	Unclear	There is insufficient information on the time period between index tests and reference standard
4	Did the whole sample or a random selection of the sample receive verification using a reference standard of diagnosis?	
	Yes	it is clear that all patients who received the index test went on to receive a reference standard, even if the reference standard is not the same for all patients
	No	Not all patients who received the index test received verification by a reference standard

	Unclear	Insufficient information is provided to assess this item
5	Did patients receive the same reference standard regardless of the index test result?	
	Yes	it is clear that all patients receiving the index test are subjected to the same reference standard
	No	Different reference standards are used
	Unclear	Insufficient information is provided to assess this item
6	Was the reference standard independent of the index test (i.e. the index test did not form part of the reference standard)?	
	Yes	Classify as 'yes' if the index test is not part of the reference standard
	No	The index test is clearly part of the reference standard
	Unclear	Insufficient information is provided to assess this item
7	Were the reference standard results interpreted without knowledge of the results of the index test?	
	Yes	Classify as 'yes' if the results of the reference standard are interpreted blind to the results of the index tests. Also, classify as 'yes' if the sequence of testing is always the same (i.e. the reference standard is always performed first, followed by the index test) and consequently, the reference standard is interpreted blind of the index test
	No	The assessor is aware of the results of the index test
	Unclear	Insufficient information is given on independent or blind assessment of the index test
8	Were the index test results interpreted without knowledge of the results of the reference standard?²	
	Yes	The results of the index test are interpreted blind to the results of the reference test. Also, classify as 'yes' if the sequence of testing is always the same (i.e. the index test is always performed first, followed by the reference standard), and consequently, the index test is interpreted blind of the reference standard
	No	The assessor is aware of the results of the reference standard
	Unclear	Insufficient information is given on independent or blind assessment of the reference standard
9	Were the same clinical data available when the index test results were interpreted as would be available when the test is used in practice?²	
	Yes	Clinical data (i.e. patient history, other physical tests) would normally be available when the test results are interpreted and similar data are available in the study. Also, classify as 'yes' if clinical data would normally not be available when the test results are interpreted and these data are also not available in the study
	No	This is not the case, e.g. if other test results are available that cannot be regarded as part of routine care

	Unclear	The paper does not explain which clinical information was available at the time of assessment
10	Were uninterpretable / intermediate test results reported?	
	Yes	All test results are reported for all patients, including uninterpretable, indeterminate, or intermediate results. Also, classify as 'yes' if the authors do not report any uninterpretable, indeterminate, or intermediate results AND the results are reported for all patients who were described as having been entered into the study
	No	There is suspicion that such results occurred, but have not been reported
	Unclear	It is unclear whether all results have been reported
11	Were withdrawals from the study explained?	
	Yes	It is clear what happens to all patients who entered the study (all patients are accounted for, preferably in a flow chart). Also, classify as 'yes' if the authors do not report any withdrawals AND if the results are available for all patients who were reported to have been entered in the study
	No	It is clear that not all patients who were entered completed the study (received both index test and reference standard) , and not all patients are accounted for.
	Unclear	The paper does not clearly describe whether or not all patients completed all tests, and are included in the analysis

Table B: Characteristics of included studies for detection of fracture.

Author - condition	Clinical features and settings	Participants	Study design	Representative spectrum?	Reference standard(s)	Index and comparator tests (red flags)	Follow up
Deyo 1986 - fracture - malignancy	Walk-in clinic, USA. Back pain as primary complaint.	1108 patients. 487 were excluded (one or more of pain above T12, urinary tract disease, contra-indication for x-ray e.g. chance of pregnancy, missing x-ray/lab results). 72% with LBP duration less than 1 month; first medical care for back pain in 53%. Study sample was of 621 patients with mean age of 41 years (range 15-86 years).	Prospective longitudinal study examining actual x-ray utilisation.	Yes: Consecutive series of patients with LBP.	The hospital tumour registry and discharge records were used to identify patients found to have a malignancy during the six months after the initial visit, and the medical records of all febrile patients were reviewed after six months.	History and physical examination data (65 items) were recorded by physicians on a standard coding form. Data available only on two index tests: patient aged > 50 years; and not improved after 1 month.	Missing or uninterpretable data not reported.
Gibson 1992 - fracture	Accident and Emergency Department, UK. Patients had pain in the lumbar region of less than 48 hours duration.	225 patients over a 6 month period. 108 patients (48%) had x-rays.	Prospective cohort	Yes: Consecutive series of patients with pain in the lumbar region. (number excluded not reported).	Plain x-ray (not further defined).	Trauma, trauma and neurological signs, neurological signs.	Missing or uninterpretable data not reported.
Henschke 2009 - fracture - malignancy	Primary care (general practice, physiotherapy or chiropractic), Australia. Patients presented with acute low back pain.	1,172 patients presenting with acute LBP, mean age 44 years (SD 15.1), 53.4% male, 72.6% from physiotherapy, 59.4% less than 1 week since onset. Participants excluded if serious pathology had been diagnosed prior to the consultation, and the serious pathology was considered to be the cause of the current episode of low-back pain.	Prospective inception cohort with 12 months follow-up.	Yes: Consecutive sample of low-back pain patients with clear inclusion Criteria.	Clinical follow-up (6 weeks, 3 months, 12 months) with suspected cases confirmed by imaging studies and specialist review.	Age > 50, gradual onset before age 40, age > 70, unexplained weight loss, previous history of malignancy, tried bed rest but no relief, insidious onset, systemically unwell, constant progressive pain, altered sensation from the trunk down.	All patients followed up 12 months after presenting to primary care. A random sample ($n = 218$) was reviewed by a rheumatologist after 12 month follow-up to confirm reference standard.

Patrick 1983 - fracture	Accident and Emergency Department and University Hospital Medical Centre, USA. All patients having lumbo-sacral x-ray series were enrolled.	552 patients with lumbar spine x-ray referral. 54% male, age range 6 to 95 years, 99% complained of LBP. Consecutive sample of patients with imaging studies ordered over 3 month period.	Retrospective chart review.	Unclear: Consecutive sample of with lumbar spine imaging requested (reason for presentation not described).	Lumbar spine bony injury: x-ray (not further defined).	Trauma, tenderness, LBP with radiation and/or hip pain, spasm, sensory deficit, motor deficit, tendon reflex abnormality, +ve straight leg raise, contusion/abrasion, multiple findings (distinction between fracture and other bony injury unclear for some index tests).	Missing or uninterpretable data not reported.
Reinus 1998 - fracture - malignancy	Level II Accident and Emergency Department, USA. All patients receiving lumbosacral x-ray were enrolled.	482 patients over a 14 month period. 35% male, mean age 56 years (range 17 to 98). 92% with back pain.	Prospective cohort.	Unclear: Consecutive sample of patients with lumbosacral imaging.	Suspected clinical diagnosis including fracture and spondylosis: lumbosacral AP, lateral, bi-lateral posterior oblique and coned down radiological views.	Fracture: trauma, neurological deficit. Malignancy: previous history of malignancy.	Missing or uninterpretable data not reported.
Roman 2010 - fracture	University Hospital Spine Clinic, USA. All patients with a lumbar related disorder and available imaging were enrolled.	1448 patients with lumbar-related disorders over a 5 year period. 41% male.	Retrospective chart review.	YES: Consecutive sample of patients with lumbar disorders	Compression fracture or wedge deformity: standard radiograph or CT assessing sagittal alignment, vertebral body compression and spinal canal dimensions.	Leg or buttock pain, gender, age, BMI, gait abnormality, regular exercise, sitting pain, osteoarthritis, multiple signs.	Missing or uninterpretable data not reported.
Scavone 1981 - fracture	University teaching hospital medical centre, USA. All patients with lumbar spine x-ray were enrolled.	871 patients in 12-month period. 695 (80%) were outpatients.	Retrospective chart review.	Unclear: selection criteria not clear.	Abnormal x-ray finding including fracture: AP and lateral x-ray views	Major trauma, minor trauma, tenderness, LBP with radiation, hip/leg pain, muscle spasm, neurological deficits, sciatica, abnormal physical examination.	Missing or uninterpretable data not reported.
van den Bosch 2004 - fracture	University hospital medical centre, UK. A random sample of 2100 lumbar spine radiology reports from 6269 patients referred by general practitioners.	2007 patients with full radiographic and demographic details, 42% were men, mean age was 50 years for men and 57 for women.	Retrospective chart review.	Yes: Random sample of patients with LBP referred for imaging by general practitioners.	Serious radiological findings including fracture x-ray (not further defined).	Age, gender.	Missing or uninterpretable data not reported.

Table C: Characteristics of included studies for detection of malignancy.

Author - target condition	Clinical features and settings	Participants	Study design	Representative spectrum?	Reference standard(s)	Index and comparator tests (red flags)	Follow up
Cook 2012 - malignancy	Spine surgery centre, USA. Patients with low back pain awaiting surgical opinion.	Clinical file notes of 1,109 patients from 1,161 consecutive files from 2004 – 2010. 87% had chronic thoracolumbar pain. Mean age 54.8 years (SD 16.3). 59% were female.	Retrospective database exploration to record results of demographic, physical examination, and psychological status.	Yes: Consecutive series of patient data over 6 years with clear inclusion criteria.	MRI was the most common method used (not further defined).	No increase in pain during clinical movement screen; age > 50 years; scoliosis; kyphosis; and midline spine tenderness.	Missing or uninterpretable data partially reported via communication with author.
Deyo 1986 - fracture - malignancy	Walk-in clinic, USA. Back pain as primary complaint.	1108 patients. 487 were excluded (one or more of pain above T12, urinary tract disease, contra-indication for x-ray e.g. chance of pregnancy, missing x-ray/lab results). 72% with LBP duration less than 1 month; first medical care for back pain in 53%. Study sample was of 621 patients with mean age of 41 years (range 15-86 years).	Prospective longitudinal study examining actual x-ray utilisation, and assessing the potential effects of applying selective criteria for x-ray utilisation.	Yes: Consecutive series of patients with LBP.	The hospital tumour registry and discharge records were used to identify patients found to have a malignancy during the six months after the initial visit, and the medical records of all febrile patients were reviewed after six months.	History and physical examination data (65 items) were recorded by physicians on a standard coding form. Data available only on two index tests: patient aged > 50 years; and not improved after 1 month.	Missing or uninterpretable data not reported.
Deyo 1988 - malignancy	Walk-in clinic, USA. Back pain as primary complaint.	1975 patients with a mean age of 40 years (range 15-86 years). 54% were seeking medical care for back pain for the first time, and 76% had pain for less than three months.	Prospective longitudinal study, participants underwent history and physical examination (index tests) at initial consultation.	Yes: Consecutive series of patients with LBP seeking treatment at a walk-in clinic.	Institutional tumour registry at least six months after the index visit.	History and physical examination data (65 items) were recorded by physicians on a standard coding form. Data available on multiple index tests	Missing or uninterpretable data not reported.
Donner-	Primary care,	1353 patients with a mean	Cluster-randomised	Yes:	At the 12-month follow-	A written	Of 1378 patients

Banzhoff 2006 - malignancy	Germany. Back pain as primary complaint.	age of 49 years (range 20-91 years). Exclusion criteria were insufficient language skills, pregnancy and isolated thoracic pain.	controlled trial evaluating strategies to improve the quality of care. 12 months after entering study, data were collected by telephone follow-up.	Consecutive series of patients with LBP presenting to primary care.	up, highly sensitive filter questions related to relevant serious conditions that might have caused LBP at the time of recruitment were asked, then interviewed by telephone (delayed-type reference standard).	questionnaire at baseline included the question: "Is the low-back pain familiar to you?" which could be answered "yes" or "no".	recruited, 1353 answered the question with regard to the familiarity of their LBP. Of these patients, 1190 were available for follow-up at 1 year.
Frazier 1989 - malignancy	Walk-in clinic, USA. Acute back pain as primary complaint.	Clinic logs revealed 1037 patients who presented with back pain during the study period. Medical records were reviewed for 863 (83%) patients. 471 had acute lumbosacral back pain and mean age of 41 years (range 15-90 years). 392 were excluded.	Retrospective review of medical records for patients with presenting complaints of "back pain" or "sore back". Records were reviewed at least six months after the initial presentation.	Yes: Patients presenting with low-back pain to medical walk-in clinics.	Clinical notes were examined to determine if the initial back pain episode was ultimately attributed to vertebral malignancy, osteomyelitis, vertebral fracture, or herniated disk.	18 patient characteristics were recorded. Data was only available for index test age > 50 years.	Missing or uninterpretable data not reported.
Henschke 2009 - fracture - malignancy	Primary care (general practice, physiotherapy or chiropractic), Australia. Patients presented with acute low back pain.	1,172 patients presenting with acute LBP, mean age 44 years (SD 15.1), 53.4% male, 72.6% from physiotherapy, 59.4% less than 1 week since onset. Participants excluded if serious pathology had been diagnosed prior to the consultation, and the serious pathology was considered to be the cause of the current episode of low-back pain.	Prospective inception cohort with 12 months follow-up.	Yes: Consecutive sample of low-back pain patients with clear inclusion Criteria.	Clinical follow-up (6 weeks, 3 months, 12 months) with suspected cases confirmed by imaging studies and specialist review.	Age > 50, gradual onset before age 40, age > 70, unexplained weight loss, previous history of malignancy, tried bed rest but no relief, insidious onset, systemically unwell, constant progressive pain, altered sensation from the trunk down.	All patients followed up 12 months after presenting to primary care. A random sample ($n = 218$) was reviewed by a rheumatologist after 12 month follow-up to confirm reference standard.
Jacobsen 1997 - malignancy	Secondary referrals for bone scintigraphy, USA. Patients without prior history of	491 patients with a mean age of 56 years (range 21 to 49). 257 (52%) had complaints of middle to lower back pain, with 99 patients younger than 50	Retrospective review of consecutive bone scintigraphy scans.	No: Patients referred for bone scan with complaints of musculoskeletal or bone and	Scan results were classified into categories (no findings suggestive of malignancy, equivocal, or probable metastatic disease).	Data only available on one index test: age > 50 years.	Missing or uninterpretable data not reported.

	malignancy who underwent bone scans to investigate musculoskeletal complaints.	years and 158 patients aged 50 years or older.		joint pain.	Scans with reports were reviewed (unblinded) by the author to verify the original interpretations. Records for all patients were reviewed to identify diagnoses of malignancy established subsequent to the scan results.		
Khoo 2003 - malignancy	General practice, UK. (UK). Clinical indications for referral included mechanical or pathological conditions	1030 patients with mean age of 53 years (range 10-100 years). Referrals for lumbar spine radiographs were enrolled without exclusion.	Prospective study of consecutive referrals for lumbar spine radiograph.	Yes: Consecutive general practice referrals for lumbar spine radiograph.	Two-view lumbar spine radiographs were taken as standard - an anteroposterior (AP) and a lateral view. Radiological analysis was shared between six consultant radiologists using a standard format.	Data only available on one index test: neurological symptoms.	Missing or uninterpretable data not reported.
Reinus 1998 - fracture - malignancy	Level II Accident and Emergency Department, USA. All patients receiving lumbosacral x-ray were enrolled.	482 patients over a 14 month period. 35% male, mean age 56 years (range 17 to 98). 92% with back pain.	Prospective cohort.	Unclear: Consecutive sample of patients with lumbosacral imaging.	Suspected clinical diagnosis including fracture and spondylosis: lumbosacral AP, lateral, bi-lateral posterior oblique and coned down radiological views.	Fracture: trauma, neurological deficit. Malignancy: previous history of malignancy.	Missing or uninterpretable data not reported.

Table D: Methodological quality summary for each included study based on QUADAS checklist.

Study	Condition screened	Representative spectrum?	Acceptable reference standard?	Acceptable delay between	Partial verification avoided?	Differential verification	Incorporation avoided?	Reference standard results	Index test results blinded?	Relevant clinical information?	Uninterpretable results	Withdrawals explained?
Cook, 2012 ³⁷	Malignancy	+	+	+	-	?	+	?	+	+	-	-
Deyo, 1986 ²⁷	Fracture	+	+	+	-	?	+	-	+	+	-	?
Deyo, 1986 ²⁷	Malignancy	+	+	+	-	?	+	?	?	+	-	?
Deyo, 1988 ³¹	Malignancy	+	+	?	?	?	+	+	?	+	-	-
Donner-Banzhoff,	Malignancy	+	+	?	+	+	+	?	+	+	?	?
Frazier, 1989 ²⁹	Malignancy	+	+	?	-	-	?	?	?	?	-	-
Gibson, 1992 ³⁶	Fracture	+	+	?	-	?	+	-	+	+	-	?
Henschke, 2009 ⁶	Fracture	+	-	?	+	+	?	?	+	+	+	+
Henschke, 2009 ⁶	Malignancy	+	+	?	+	+	?	?	+	+	+	+
Jacobson, 1997 ³²	Malignancy	-	+	?	+	+	+	?	+	?	?	?
Khoo, 2003 ²⁸	Malignancy	+	+	?	+	+	?	?	+	?	-	-
Patrick, 1983 ³⁵	Fracture	?	+	+	+	+	+	?	?	+	-	?
Reinus, 1998 ³⁴	Fracture	?	+	?	?	?	+	-	+	+	-	+
Reinus, 1998 ³⁴	Malignancy	+	+	+	?	?	+	-	+	?	-	+
Roman, 2010 ³³	Fracture	+	+	+	+	-	+	?	?	+	+	+
Scavone, 1981 ²⁶	Fracture	?	+	?	?	?	+	?	+	+	-	-
Van den Bosch, 2004 ²⁵	Fracture	+	+	?	-	+	+	?	+	+	-	-

QUADAS: Quality Assessment of Diagnostic Accuracy Studies. “+” and “-” represent “yes” (adequately addressed), and “no” (inadequately addressed) respectively. “?” represents “unclear” (inadequate detail presented to allow a judgment to be made).

Table E: Results of included studies for detection of spinal fracture in primary care.

Index test	Author	n	Dis- ease	Study prev.	TP	FP	FN	TN	Sensitivity	Specificity	LR+ (95% CI)	LR- (95% CI)
Demographic												
Age >50 years	Deyo 1986	621	28	0.0451	11	108	3	189	0.79 (0.49 to 0.95)	0.64 (0.58 to 0.69)	2.16 (1.58 to 2.95)	0.34 (0.12 to 0.92)
	Henschke 2009	1172	8	0.0068	5	395	3	769	0.63 (0.24 to 0.91)	0.66 (0.63 to 0.69)	1.84 (1.07 to 3.17)	0.57 (0.23 to 1.39)
Age >54 years	van den Bosch 2004	2100	86	0.0410	69	932	14	992	0.83 (0.73 to 0.90)	0.52 (0.49 to 0.54)	1.72 (1.54 to 1.91)	0.33 (0.20 to 0.53)
	Henschke 2009	1172	8	0.0068	5	283	3	881	0.63 (0.24 to 0.91)	0.76 (0.73 to 0.78)	2.57 (1.49 to 4.44)	0.50 (0.20 to 1.21)
Age >64 years	Henschke 2009	1172	8	0.0068	5	102	3	1062	0.63 (0.24 to 0.91)	0.91 (0.89 to 0.93)	7.13 (4.04 to 12.59)	0.41 (0.17 to 1.01)
	van den Bosch 2004	2100	86	0.0410	65	613	18	1311	0.78 (0.68 to 0.87)	0.68 (0.66 to 0.70)	2.46 (2.16 to 2.80)	0.32 (0.21 to 0.48)
Age >70 years	Henschke 2009	1172	8	0.0068	4	52	4	1112	0.50 (0.16 to 0.84)	0.96 (0.94 to 0.97)	11.19 (5.33 to 23.51)	0.52 (0.26 to 1.05)
Age >74 years	Henschke 2009	1172	8	0.0068	2	31	6	1133	0.25 (0.03 to 0.65)	0.97 (0.96 to 0.98)	9.39 (2.69 to 32.75)	0.77 (0.52 to 1.15)
	van den Bosch 2004	2100	86	0.0410	49	308	34	1616	0.59 (0.48 to 0.70)	0.84 (0.82 to 0.86)	3.69 (3.00 to 4.53)	0.49 (0.38 to 0.63)
Female	van den Bosch 2004	2100	86	0.0410	60	1101	23	823	0.72 (0.61 to 0.82)	0.43 (0.41 to 0.45)	1.26 (1.10 to 1.45)	0.65 (0.46 to 0.92)
History												
Hip/Leg pain	Scavone 1981	871	26	0.0299	0	73	26	772	0.00 (0.00 to 0.13)	0.91 (0.89 to 0.93)	0.21 (0.01 to 3.35)	1.07 (1.02 to 1.14)
Sciatica	Scavone 1981	871	26	0.0299	1	77	25	768	0.04 (0.00 to 0.20)	0.91 (0.89 to 0.93)	0.42 (0.06 to 2.92)	1.06 (0.98 to 1.15)
Significant trauma*	Deyo 1986	621	28	0.0451	5	31	9	266	0.36 (0.13 to 0.65)	0.90 (0.86 to 0.93)	3.42 (1.57 to 7.45)	0.72 (0.48 to 1.06)
	Henschke 2009	1172	8	0.0068	2	29	6	1135	0.25 (0.03 to 0.65)	0.98 (0.96 to 0.98)	10.03 (2.87 to 35.13)	0.77 (0.52 to 1.15)
	Scavone 1981	871	26	0.0299	17	43	9	802	0.65 (0.44 to 0.83)	0.95 (0.93 to 0.96)	12.85 (8.58 to 19.24)	0.36 (0.21 to 0.62)
Steroid use	Deyo 1986	621	28	0.0451	0	2	14	295	0.00 (0.00 to 0.23)	0.99 (0.98 to 1.00)	3.97 (0.20 to 79.15)	0.97 (0.89 to 1.07)
Prolonged use steroid	Henschke 2009	1172	8	0.0068	2	6	6	1158	0.25 (0.03 to 0.65)	0.99 (0.99 to 1.00)	48.5 (11.48 to 204.99)	0.75 (0.51 to 1.12)
Spasm	Scavone 1981	871	26	0.0299	3	78	23	767	0.12 (0.02 to 0.30)	0.91 (0.89 to 0.93)	1.25 (0.42 to 3.70)	0.97 (0.85 to 1.12)
Tenderness	Scavone 1981	871	26	0.0299	13	225	13	620	0.50 (0.30 to 0.70)	0.73 (0.70 to 0.76)	1.88 (1.26 to 2.80)	0.68 (0.46 to 1.00)
DTR abnormal	Scavone 1981	871	26	0.0299	3	90	23	755	0.12 (0.02 to 0.30)	0.89 (0.87 to 0.91)	1.08 (0.37 to 3.20)	0.99 (0.86 to 1.14)
Motor deficit	Scavone 1981	871	26	0.0299	6	89	20	756	0.23 (0.09 to 0.44)	0.89 (0.87 to 0.91)	2.19 (1.06 to 4.54)	0.86 (0.70 to 1.06)
Sensory change	Henschke 2009	1172	8	0.0068	0	19	8	1145	0.00 (0.00 to 0.37)	0.98 (0.97 to 0.99)	3.32 (0.22 to 50.68)	0.96 (0.82 to 1.13)
	Scavone 1981	871	26	0.0299	7	103	19	742	0.27 (0.12 to 0.48)	0.88 (0.85 to 0.90)	2.21 (1.14 to 4.27)	0.83 (0.66 to 1.05)

Combined tests

Age >54 years + Female	Henschke 2009	1172	8	0.0068	5	135	3	1029	0.63 (0.24 to 0.91)	0.88 (0.86 to 0.90)	5.39 (3.08 to 9.43)	0.42 (0.17 to 1.04)
	van den Bosch 2004	2100	86	0.0410	52	600	31	1324	0.63 (0.51 to 0.73)	0.69 (0.67 to 0.71)	2.01 (1.68 to 2.4)	0.54 (0.41 to 0.72)
Age >64 years + Female	Henschke 2009	1172	8	0.0068	5	50	3	1117	0.63 (0.24 to 0.91)	0.96 (0.94 to 0.97)	14.59 (7.99 to 26.62)	0.39 (0.16 to 0.96)
	van den Bosch 2004	2100	86	0.0410	49	413	34	1511	0.59 (0.48 to 0.70)	0.79 (0.77 to 0.80)	2.75 (2.25 to 3.35)	0.52 (0.40 to 0.68)
Age >74 years + Female	Henschke 2009	1172	8	0.0068	2	18	6	1146	0.25 (0.03 to 0.65)	0.98 (0.98 to 0.99)	16.17 (4.47 to 58.43)	0.76 (0.51 to 1.14)
	van den Bosch 2004	2100	86	0.0410	37	207	46	1717	0.45 (0.34 to 0.56)	0.89 (0.88 to 0.91)	4.14 (3.16 to 5.44)	0.62 (0.51 to 0.75)
Henschke 1 positive test†	Henschke 2009	1172	8	0.0068	7	582	1	582	0.88 (0.47 to 1.00)	0.50 (0.47 to 0.53)	1.75 (1.34 to 2.29)	0.25 (0.04 to 1.57)
Henschke 2 positive tests†	Henschke 2009	1172	8	0.0068	5	47	3	1117	0.63 (0.24 to 0.91)	0.96 (0.95 to 0.97)	15.48 (8.45 to 28.36)	0.39 (0.16 to 0.96)
Henschke 3 positive tests†	Henschke 2009	1172	8	0.0068	3	0	5	1164	0.38 (0.09 to 0.76)	1.00 (1.00 to 1.00)	916 (50 to 16300)	0.61 (0.36 to 1.03)

*Significant trauma: trauma such as a fall from a height or motor vehicle accident (Deyo 1986); trauma which is major in young patients and minor in elderly patients (Henschke 2009); trauma which is minor in elderly women with osteoporosis (Scavone 1981). †Henschke index tests: female gender, age >70 years, significant trauma, and prolonged use of corticosteroids.

Table F: Results of included studies for detection of spinal fracture in secondary and tertiary care.

Index test	Author	n	Dis- ease	Study prev.	TP	FP	FN	TN	Sensitivity	Specificity	LR+ (95% CI)	LR- (95% CI)
Secondary care												
Age >52 years	Roman 2010	1448	38	0.0262	36	867	2	554	0.95 (0.82 to 0.99)	0.39 (0.36 to 0.42)	1.55 (1.43 to 1.69)	0.13 (0.03 to 0.52)
Female	Roman 2010	1448	38	0.0262	34	832	4	578	0.89 (0.75 to 0.97)	0.41 (0.38 to 0.44)	1.52 (1.35 to 1.71)	0.26 (0.10 to 0.65)
History												
No buttock/ leg pain	Roman 2010	1448	38	0.0262	12	199	26	1211	0.32 (0.18 to 0.49)	0.86 (0.84 to 0.88)	2.24 (1.38 to 3.64)	0.80 (0.64 to 0.99)
Decreased pain on sitting	Roman 2010	1448	38	0.0262	11	262	27	1148	0.29 (0.15 to 0.46)	0.81 (0.79 to 0.83)	1.56 (0.94 to 2.59)	0.87 (0.71 to 1.07)
No regular exercise	Roman 2010	1448	38	0.0262	31	785	7	625	0.82 (0.66 to 0.92)	0.44 (0.42 to 0.47)	1.47 (1.25 to 1.72)	0.42 (0.21 to 0.81)
Examination												
BMI < 23	Roman 2010	1448	38	0.0262	14	234	24	1176	0.37 (0.22 to 0.54)	0.83 (0.81 to 0.85)	2.22 (1.44 to 3.42)	0.76 (0.59 to 0.97)
No gait abnormality	Roman 2010	1448	38	0.0262	25	1086	13	324	0.66 (0.49 to 0.80)	0.23 (0.21 to 0.25)	0.85 (0.68 to 1.08)	1.49 (0.95 to 2.34)
OA	Roman 2010	1448	38	0.0262	19	671	19	739	0.50 (0.33 to 0.67)	0.52 (0.50 to 0.55)	1.05 (0.76 to 1.45)	0.95 (0.69 to 1.32)
Combined tests												
Roman 1 positive test*	Roman 2010	1448	38	0.0262	37	1324	1	87	0.97 (0.86 to 1.00)	0.06 (0.05 to 0.08)	1.04 (0.98 to 1.1)	0.43 (0.06 to 2.98)
Roman 2 positive tests*	Roman 2010	1448	38	0.0262	36	933	2	478	0.95 (0.82 to 0.99)	0.34 (0.31 to 0.36)	1.43 (1.32 to 1.56)	0.16 (0.04 to 0.60)
Roman 3 positive tests*	Roman 2010	1448	38	0.0262	29	440	9	970	0.76 (0.60 to 0.89)	0.69 (0.66 to 0.71)	2.45 (2.02 to 2.97)	0.34 (0.19 to 0.61)
Roman 4 positive tests*	Roman 2010	1448	38	0.0262	14	54	24	1356	0.37 (0.22 to 0.54)	0.96 (0.95 to 0.97)	9.62 (5.88 to 15.73)	0.66 (0.52 to 0.84)
Roman 5 positive tests*	Roman 2010	1448	38	0.0262	1	5	36	1406	0.03 (0.00 to 0.14)	1.00 (0.99 to 1.00)	7.63 (0.91 to 63.68)	0.98 (0.93 to 1.03)
Tertiary care												
History												
Contusion/ abrasion	Patrick 1983	552	40	0.0725	34	14	6	498	0.85 (0.70 to 0.94)	0.97 (0.95 to 0.98)	31.09 (18.25 to 52.96)	0.15 (0.07 to 0.32)
Trauma†	Gibson 1992	225	15	0.0649	7	49	0	52	1.00 (0.59 to 1.00)	0.51 (0.41 to 0.62)	1.93 (1.48 to 2.53)	0.12 (0.01 to 1.79)

	Patrick 1983	552	40	0.0725	32	231	8	281	0.80 (0.64 to 0.91)	0.55 (0.50 to 0.59)	1.77 (1.48 to 2.13)	0.36 (0.20 to 0.68)
	Reinus 1998	482	53	0.1100	4	169	51	258	0.07 (0.02 to 0.18)	0.60 (0.56 to 0.65)	0.18 (0.07 to 0.48)	1.53 (1.38 to 1.71)
Spasm	Patrick 1983	552	40	0.0725	10	87	30	425	0.25 (0.13 to 0.41)	0.83 (0.79 to 0.86)	1.47 (0.83 to 2.6)	0.9 (0.75 to 1.09)
Examination												
Tenderness	Patrick 1983	552	40	0.0725	29	211	11	301	0.72 (0.56 to 0.85)	0.59 (0.54 to 0.63)	1.76 (1.42 to 2.19)	0.47 (0.28 to 0.78)
DTR abnormality	Patrick 1983	552	40	0.0725	3	25	37	487	0.07 (0.02 to 0.20)	0.95 (0.93 to 0.97)	1.54 (0.48 to 4.87)	0.97 (0.89 to 1.06)
Motor deficit‡	Patrick 1983	552	40	0.0725	1	4	40	508	0.02 (0.00 to 0.13)	0.99 (0.98 to 1.00)	3.12 (0.36 to 27.29)	0.98 (0.94 to 1.03)
Sensation change	Patrick 1983	552	40	0.0725	1	9	39	503	0.03 (0.00 to 0.13)	0.98 (0.97 to 0.99)	1.42 (0.18 to 10.95)	0.99 (0.94 to 1.04)
SLR	Patrick 1983	552	40	0.0725	7	88	33	424	0.17 (0.07 to 0.33)	0.83 (0.79 to 0.86)	1.02 (0.51 to 2.05)	1.00 (0.86 to 1.16)
Neurological signs¶	Gibson 1992	225	14.6	0.0649	2	12	5	89	0.29 (0.04 to 0.71)	0.88 (0.80 to 0.94)	2.4 (0.66 to 8.7)	0.81 (0.50 to 1.30)
	Reinus 1998	482	53	0.1100	3	34	52	393	0.05 (0.01 to 0.15)	0.92 (0.89 to 0.94)	0.69 (0.22 to 2.16)	1.03 (0.96 to 1.10)
Multiple findings	Patrick 1983	552	40	0.0725	17	106	23	406	0.42 (0.27 to 0.59)	0.79 (0.76 to 0.83)	2.05 (1.38 to 3.06)	0.73 (0.55 to 0.95)
Trauma and neurological signs	Gibson 1992	225	14.6	0.0649	2	2	5	99	0.29 (0.04 to 0.71)	0.98 (0.93 to 1.00)	14.43 (2.38 to 87.65)	0.73 (0.46 to 1.17)

BMI = Body mass index; DTR = Deep tendon reflex; OA = Osteoarthritis; SLR = Straight leg raise.

*Roman index tests: leg or buttock pain, gender, age, BMI, gait abnormality, no regular exercise, sitting pain, OA. †Trauma: History of direct trauma (Gibson 1992); history of trauma (Patrick 1983, Reinus 1998). ‡Motor deficit: weakness or atrophy. ¶Neurological signs and/or straight leg raise < 40° (Gibson 1992); neurological deficit (Reinus 1998).

Table G: Results of included studies for detection of spinal malignancy (all care settings).

Index test	Author	n	Dis- ease	Prev.	TP	FP	FN	TN	Sensitivity	Specificity	LR+ (95% CI)	LR- (95% CI)
Primary care												
Demographic												
Age >50 years	Deyo 1986	621	4	0.0064	3	185	1	432	0.75 (0.19 to 0.99)	0.70 (0.66 to 0.74)	2.5 (1.4 to 4.46)	0.36 (0.07 to 1.95)
	Deyo 1988	1975	13	0.0066	10	562	3	1377	0.77 (0.46 to 0.95)	0.71 (0.69 to 0.73)	2.65 (1.95 to 3.6)	0.32 (0.12 to 0.88)
	Frazier 1989	471	1	0.0021	1	122	1	347	0.50 (0.01 to 0.99)	0.74 (0.70 to 0.78)	1.92 (0.48 to 7.75)	0.68 (0.17 to 2.70)
	Henschke 2009	1172	0	0.0000	0	400	0	772	Not estimable	0.66 (0.63 to 0.69)	Not estimable	Not estimable
Age >70 years	Henschke 2009	1172	0	0.0000	0	56	0	1116	Not estimable	0.95 (0.94 to 0.96)	Not estimable	Not estimable
History												
Constant progressive pain	Henschke 2009	1172	0	0.0000	0	33	0	1139	Not estimable	0.97 (0.96 to 0.98)	Not estimable	Not estimable
Is the low-back pain familiar?	Donner-Banzhoff 2006	1353	1	0.0007	0	203	1	986	0.00 (0.00 to 0.97)	0.83 (0.81 to 0.85)	1.46 (0.13 to 16.18)	0.90 (0.41 to 2.01)
Severe pain	Deyo 1988	1975	13	0.0066	3	280	10	1589	0.23 (0.05 to 0.54)	0.85 (0.83 to 0.87)	1.54 (0.57 to 4.18)	0.90 (0.67 to 1.22)
Thoracic pain	Deyo 1988	1975	13	0.0066	2	307	10	1613	0.17 (0.02 to 0.48)	0.84 (0.82 to 0.86)	1.04 (0.29 to 3.71)	0.99 (0.77 to 1.28)
Gradual onset before age 40	Henschke 2009	1172	0	0.0000	0	102	0	1070	Not estimable	0.91 (0.90 to 0.93)	Not estimable	Not estimable
Insidious onset	Deyo 1988	1975	13	0.0066	8	1122	5	813	0.62 (0.32 to 0.86)	0.42 (0.40 to 0.44)	1.06 (0.69 to 1.63)	0.92 (0.46 to 1.82)
	Henschke 2009	1172	0	0.0000	0	202	0	970	Not estimable	0.83 (0.80 to 0.85)	Not estimable	Not estimable
Recent back injury	Deyo 1988	1975	13	0.0066	0	351	13	1601	0.00 (0.00 to 0.25)	0.82 (0.80 to 0.84)	0.20 (0.01 to 3.02)	1.18 (1.06 to 1.30)
Tried bed rest with no relief	Deyo 1988	1975	13	0.0066	4	507	0	432	1.00 (0.40 to 1.00)	0.46 (0.43 to 0.49)	1.67 (1.24 to 2.25)	0.22 (0.02 to 3.02)
	Henschke 2009	1172	0	0.0000	0	192	0	980	Not estimable	0.84 (0.81 to 0.86)	Not estimable	Not estimable
Duration of this episode > 1 month	Deyo 1986	621	4	0.0064	6	359	6	1531	0.50 (0.21 to 0.79)	0.81 (0.79 to 0.83)	2.63 (1.48 to 4.67)	0.62 (0.35 to 1.09)
Not improved after 1 month	Deyo 1986	621	4	0.0064	1	59	3	558	0.25 (0.01 to 0.81)	0.90 (0.88 to 0.93)	2.61 (0.47 to 14.52)	0.83 (0.47 to 1.46)
Systemically unwell	Deyo 1988	1975	13	0.0066	4	196	9	1766	0.31 (0.09 to 0.61)	0.90 (0.89 to 0.91)	3.08 (1.35 to 7.04)	0.77 (0.54 to 1.11)
	Henschke 2009	1172	0	0.0000	0	27	0	1145	Not estimable	0.98 (0.97 to 0.98)	Not estimable	Not estimable
	Deyo 1988	1975	13	0.0066	2	115	11	1822	0.15 (0.02 to 0.45)	0.94 (0.93 to 0.95)	2.59 (0.72 to 9.39)	0.90 (0.71 to 1.13)
Unexplained weight loss	Henschke 2009	1172	0	0.0000	0	3	0	1169	Not estimable	1.00 (0.99 to 1.00)	Not estimable	Not estimable
Previous history of cancer	Deyo 1988	1975	13	0.0066	4	39	9	1897	0.31 (0.09 to 0.61)	0.98 (0.97 to 0.99)	15.27 (6.38 to 36.55)	0.71 (0.49 to 1.02)

	Henschke 2009	1172	0	0.0000	0	46	0	1126	Not estimable	0.96 (0.95 to 0.97)	Not estimable	Not estimable
Examination												
Altered sensation from the trunk down	Henschke 2009	1172	0	0.0000	0	19	0	1153	Not estimable	0.98 (0.97 to 0.99)	Not estimable	Not estimable
Neurological finding*	Deyo 1988	1975	13	0.0066	0	160	12	1614	0.00 (0.00 to 0.26)	0.91 (0.90 to 0.92)	0.43 (0.03 to 6.47)	1.06 (0.95 to 1.18)
	Khoo 2003	1030	2	0.0019	0	34	1	995	0.00 (0.00 to 0.97)	0.97 (0.95 to 0.98)	7.46 (0.66 to 84.17)	0.78 (0.35 to 1.73)
Muscle spasm	Deyo 1988	1975	13	0.0066	2	632	11	1226	0.15 (0.02 to 0.45)	0.66 (0.64 to 0.68)	0.45 (0.13 to 1.62)	1.28 (1.01 to 1.62)
Spine tenderness	Deyo 1988	1975	13	0.0066	2	740	11	1110	0.15 (0.02 to 0.45)	0.60 (0.58 to 0.62)	0.38 (0.11 to 1.38)	1.41 (1.12 to 1.78)
Fever (temp > 100°F)	Deyo 1988	1975	13	0.0066	0	39	13	1907	0.00 (0.00 to 0.25)	0.98 (0.97 to 0.99)	1.76 (0.11 to 27.25)	0.98 (0.89 to 1.09)
Secondary care												
Age > 50 years	Jacobson 1997	257	18	0.0700	18	140	0	99	1.00 (0.81 to 1.00)	0.41 (0.35 to 0.48)	1.66 (1.46 to 1.89)	0.06 (0.00 to 0.98)
Tertiary care												
Age ≥ 50 years	Cook 2012	1102	65	0.0595	36	672	29	366	0.55 (0.43 to 0.68)	0.35 (0.32 to 0.38)	0.86 (0.68 to 1.07)	1.27 (0.95 to 1.68)
Previous history of cancer	Reinus 1998	482	7	0.0145	7	13	0	442	1.00 (0.59 to 1.00)	0.97 (0.95 to 0.98)	31.67 (18.18 to 55.17)	0.06 (0.00 to 0.94)
Scoliosis	Cook 2012	1108	66	0.0595	9	115	57	928	0.27 (0.17 to 0.40)	0.83 (0.80 to 0.85)	1.56 (1.03 to 2.37)	0.88 (0.76 to 1.02)
Kyphosis	Cook 2012	1109	66	0.0595	30	562	36	481	0.14 (0.06 to 0.24)	0.89 (0.87 to 0.91)	1.24 (0.66 to 2.32)	0.97 (0.88 to 1.07)
Midline spine tenderness	Cook 2012	1109	66	0.0595	36	428	30	615	0.45 (0.33 to 0.58)	0.46 (0.43 to 0.49)	0.84 (0.64 to 1.11)	1.18 (0.94 to 1.49)
No pain with movement screen†	Cook 2012	1109	66	0.0595	9	115	57	928	0.55 (0.42 to 0.67)	0.59 (0.56 to 0.62)	1.33 (1.05 to 1.68)	0.77 (0.59 to 1.01)

* Neurological finding: Neuromotor changes late in disease (Deyo 1988); neurological symptoms (Khoo 2003). †Movement screen: Combined movements of flexion, extension and lateral flexion.